# Human-agent Collaboration Ontology (HACON)™:

## Implications for Designing Naturalistic C² Decision Systems

Azad M. Madni, Ph.D.
Weiwen Lin, Ph.D.

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**2800 28th Street, Suite 306 Santa Monica, CA 9040**
**310-581-5440 Fax: 310-581-5430 www.IntelSysTech**

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# Presentation Overview

- Human-agent Collaboration
- Human-agent Collaboration in $C^2$
- Understanding Agents
- Human-agent Collaboration Ontology
- Ontology Applications
- Naturalistic Decision-making Example
- Metrics
- Research Program

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# Human-agent Collaboration

- Is not one human – one agent
- Is more than human-agent communication language
- Goes well beyond human-agent interaction
- Is especially significant in complex decision-making applications

***Emphasis is on capitalizing on the respective strengths of humans and agents during collaborative decision-making***

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# Human-agent Collaboration in $C^2$

- Military decision-making applications (e.g., $C^2$) impose certain unique requirements on human-agent collaboration
  - adaptive human-agent collaboration architectures
  - dynamic function reassignment
  - decision-making under time-stress, uncertainty, risk

***Emphasis is on optimally leveraging the human role in the face of ongoing changes***

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# Understanding Agents

- Agent Roles
- Agent Classification
- Human-agent Collaboration Regimes

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# Agent Roles

- Peers
  - develop shared understanding of task, their interdependencies, and contingencies
  - achieve seamless handoffs with shared understanding of context
  - deviate from “best practice” shared role when human is overloaded and/or fatigued, or unavailable
- Associate/Colleague
  - cooperates with human but performs different tasks than humans do
  - different from peer because this agent cannot be used to replace the human
- Assistant/Staff
  - agent performs tasks on behalf of the user
  - agent(s) has a clear notion of a goal and knowledge of the task domain to achieve it
  - shared vocabulary and task domain concepts enables terse, high-level human commands
- Teacher
  - pedagogical agent with domain as well as instructional knowledge
  - goal is transfer of knowledge/skills from domain KB/agent to learner
  - learning consists of getting to know and apply concepts, skills
- Learner
  - agent “learns” to perform tasks on behalf of the user; the information-seeking policy of the user

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# Agent Classification

- User agents
  - collect relevant information from user to initiate a task
  - interpret user commands/decompose user commands
  - assign work to task agents
- Task agents
  - have knowledge of the task domain as well as other task agents or information agents
  - coordinate with other task agents and information agents
  - form plans to achieve goals
  - executes plans
- Information agents
  - provide intelligence access to collection assets
  - are initiated either top down (by user or task agent) or bottom up by occurrence of particular information patterns
  - notify other interested agents when a particular condition of interest occurs
  - actively monitor information sources

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# Human-agent Collaboration Ontology (HACON™)

- Human Representation Schema
- Software Agent Representation Schema
- Human-agent Collaboration Schema

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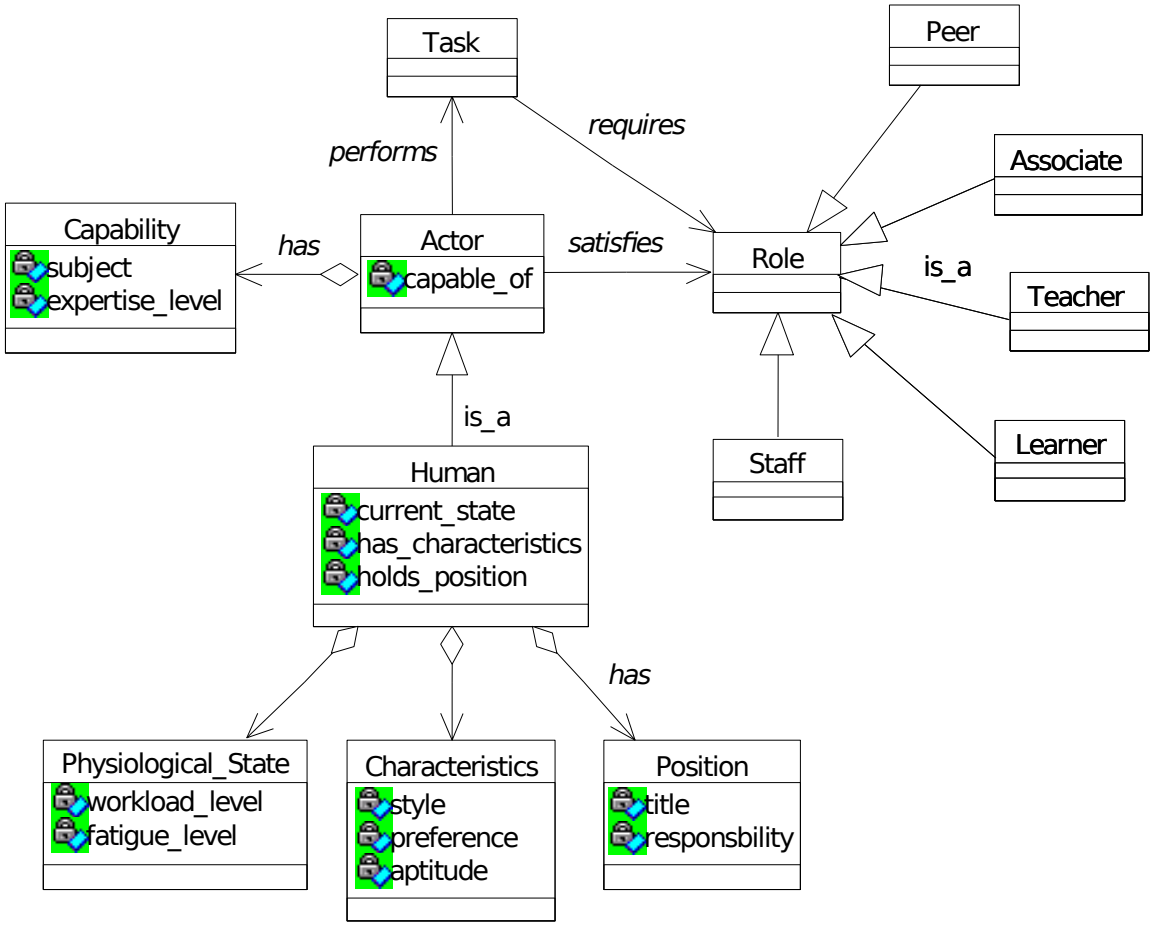
# Human Representation Schema

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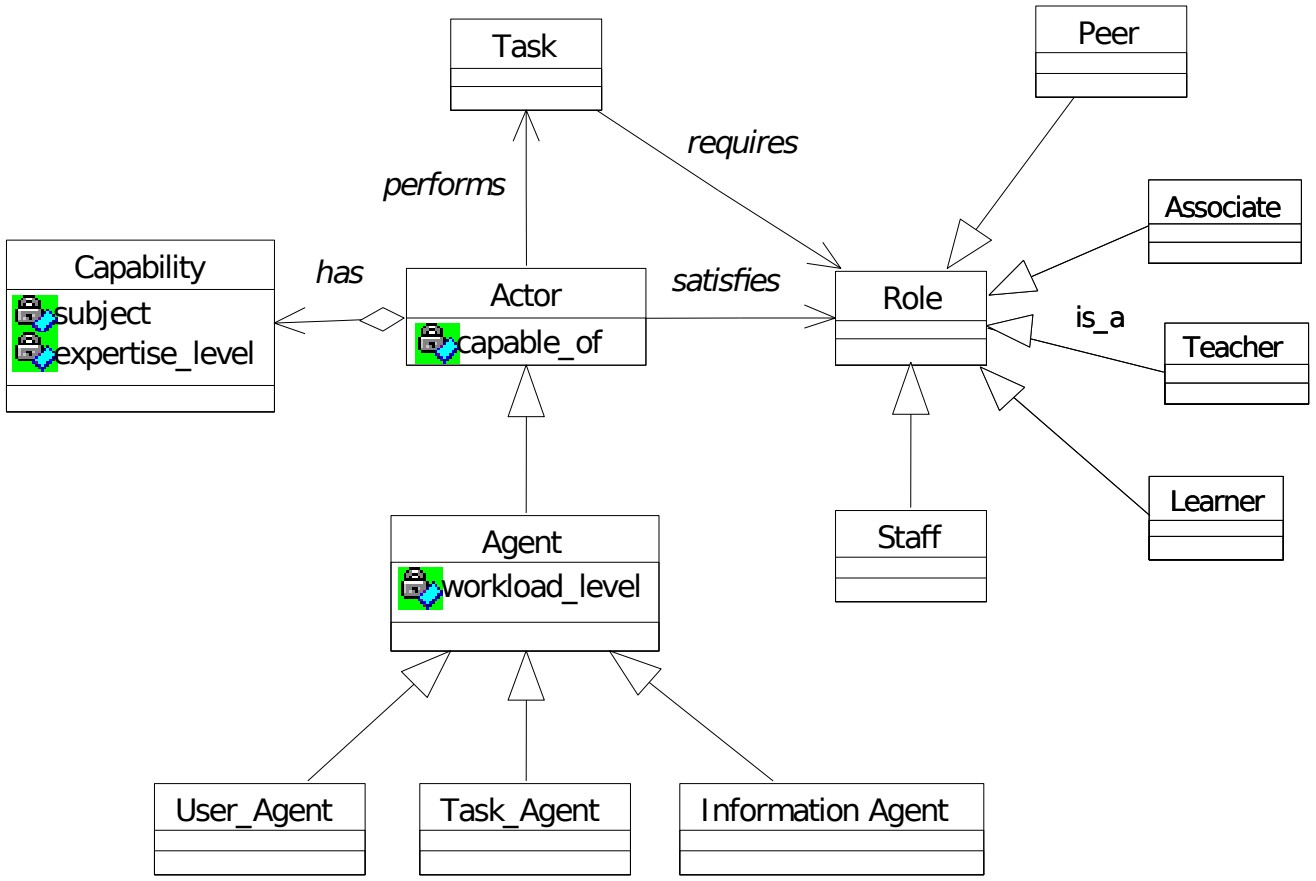
# Software Agent Representation Schema

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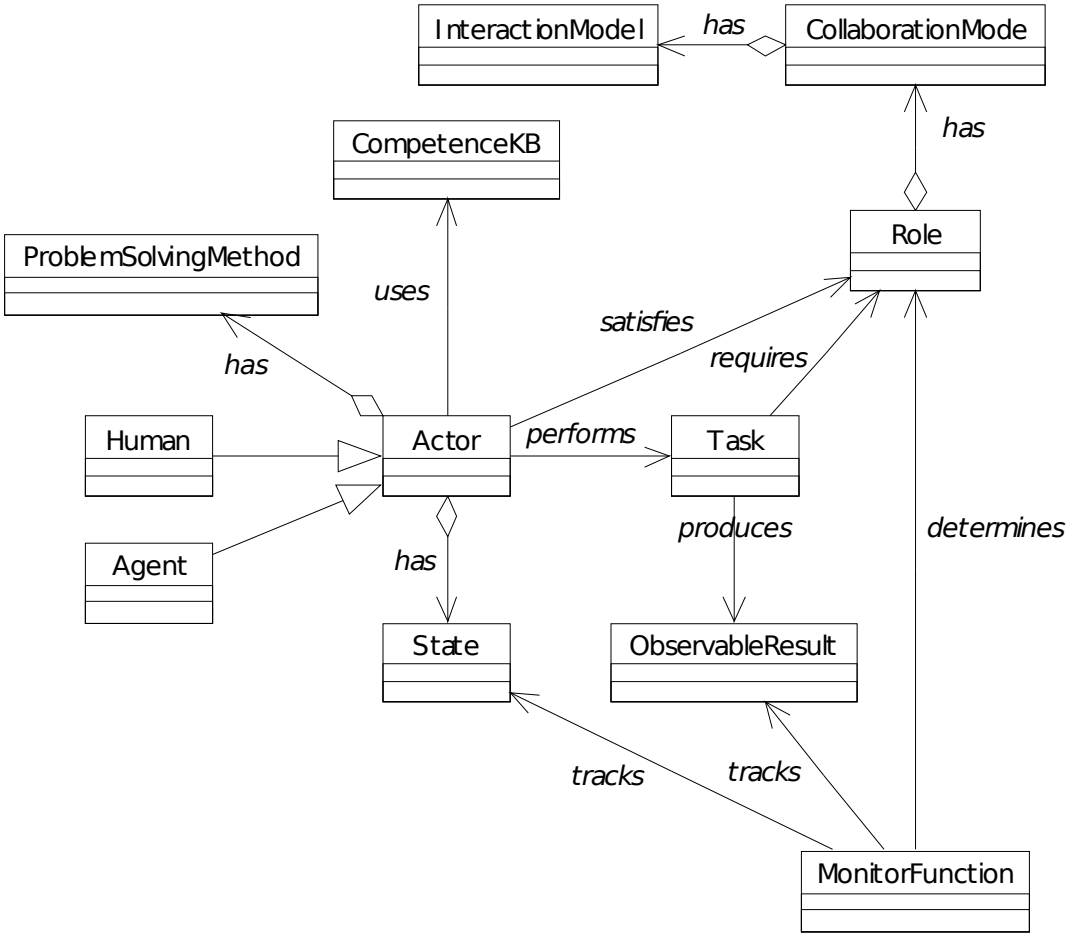
# Human-agent Collaboration Schema

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# Ontology Applications

- Decision-making
- Planning
- Decision support
- Design

***For example, HACON can be extended for naturalistic decision-making***

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# Naturalistic Decision-making

- Simply described as *"the way people use their experience to make decisions in field settings"*
- Emerged from the study of how real people make real decisions in real situations
- Well-suited to describing how decisions are made under time-stress, uncertainty, and risk

***NDM has yet to be exploited within Decision Support Systems!***

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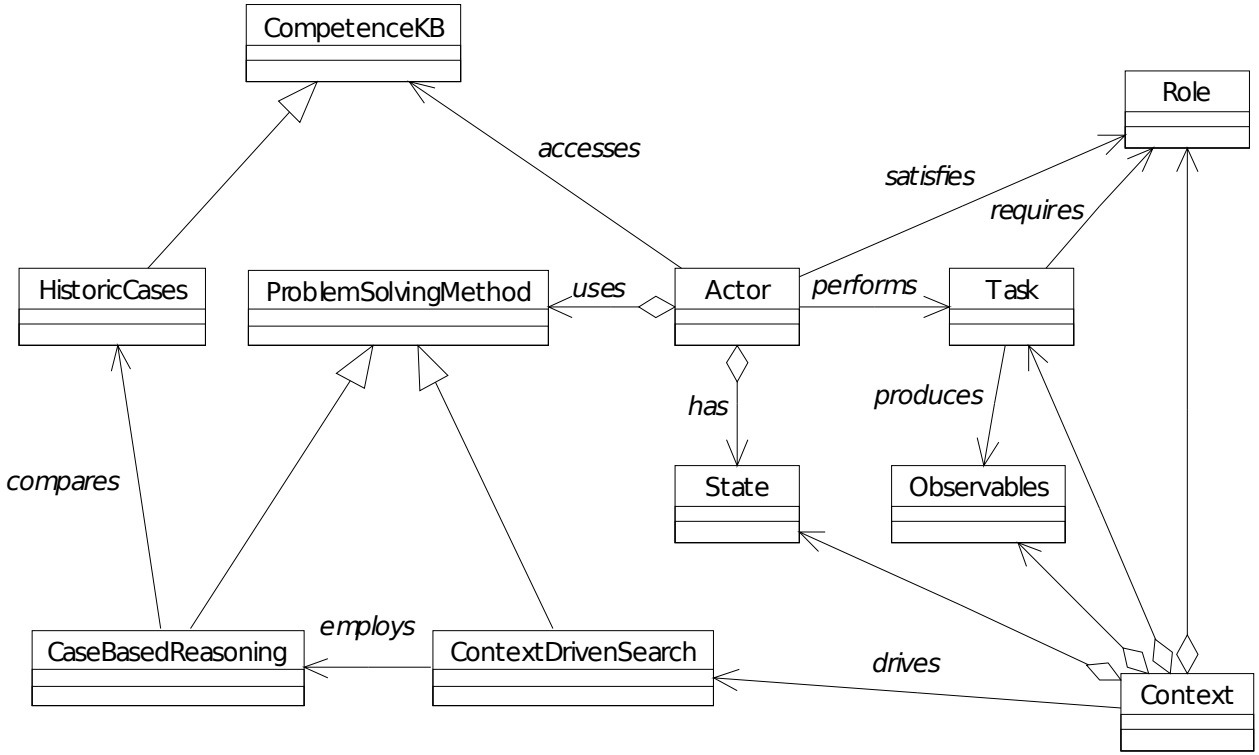
# NDM Schema...




***... is the first step to operationalizing naturalistic decision-making within DSS***

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# Case-based Reasoning...

- Exploits heuristics and knowledge of previous cases to find a solution to a current problem
- Solution typically takes the form of an adaptation of a solution to a previous case

***... is the second key component for operationalizing NDM within DSS***

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# NDM Implementation in DSS

| NDM Concepts | Implementation |
|---|---|
| Familiar Situations | – Similar cases (based on ontology) |
| Situation Familiarity Assessment | – Based on reachback for relevant cases using case-based reasoning |
| Activation of Information from Memory | – Agent tasking (user agent)<br>– Context-driven search of historical cases (information agent) |
| Evaluation of Suitability of Contemplated Action | – Case-based reasoning; similarity metrics |
| Implementation of Action | – Execution of plan/workflow associated with "best-fit" case (task agent) |

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# Sample Metrics

- Human cognitive load
- Agent utilization statistics
- Task completion times for various human-agent function assignments
- Execution delay due to function reassignment
- Execution delay due to resource unavailability
- Multi-agent synchronization delay due to function reassignment

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# Research Program

- Create “cognitively-inspired” software testbed based on HACON to investigate performance impacts of:
  - adaptive human-agent collaboration architecture
  - dynamic function reassignment options
  - context switching between human and agents
  - agent learning

***We need to understand these issues before we can effectively exploit the human role in shared human-agent C² decision-making systems.***

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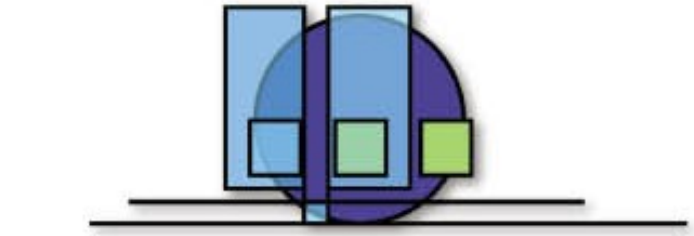

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